

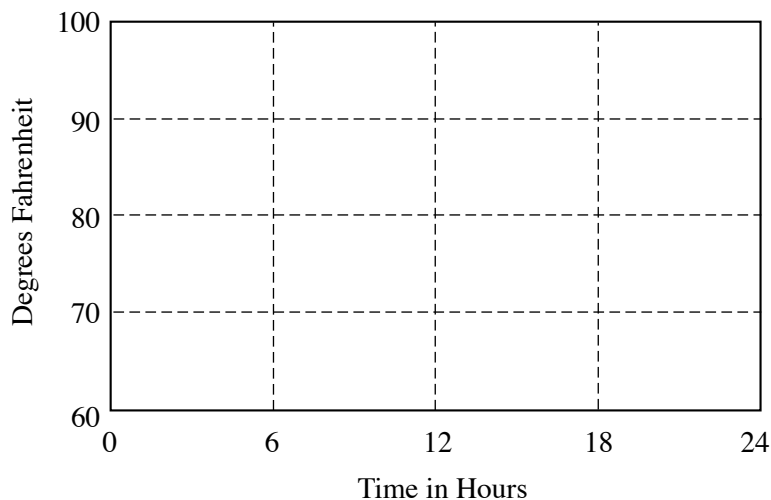
1998 AP Calculus AB Free-Response Questions

5. The temperature outside a house during a 24-hour period is given by

$$F(t) = 80 - 10 \cos\left(\frac{\pi t}{12}\right), \quad 0 \leq t \leq 24,$$

where $F(t)$ is measured in degrees Fahrenheit and t is measured in hours.

- (a) Sketch the graph of F on the grid below.



- (b) Find the average temperature, to the nearest degree Fahrenheit, between $t = 6$ and $t = 14$.
- (c) An air conditioner cooled the house whenever the outside temperature was at or above 78 degrees Fahrenheit. For what values of t was the air conditioner cooling the house?
- (d) The cost of cooling the house accumulates at the rate of \$0.05 per hour for each degree the outside temperature exceeds 78 degrees Fahrenheit. What was the total cost, to the nearest cent, to cool the house for this 24-hour period?
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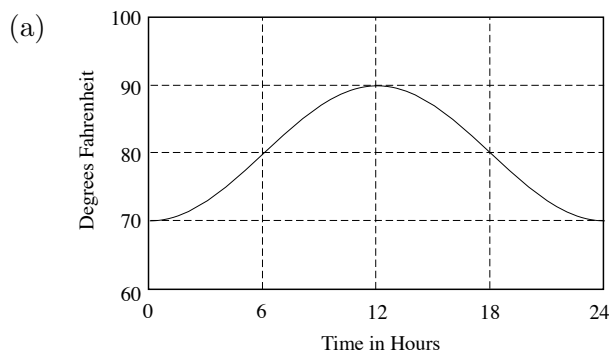
1998 Calculus AB Scoring Guidelines

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(b)
$$\text{Avg.} = \frac{1}{14 - 6} \int_6^{14} \left[80 - 10 \cos\left(\frac{\pi t}{12}\right) \right] dt$$

$$= \frac{1}{8} (697.2957795)$$

$$= 87.162 \quad \text{or} \quad 87.161$$

$$\approx 87^\circ \text{ F}$$

(c)
$$\left[80 - 10 \cos\left(\frac{\pi t}{12}\right) \right] - 78 \geq 0$$

$$2 - 10 \cos\left(\frac{\pi t}{12}\right) \geq 0$$

$$\left. \begin{array}{l} 5.230 \\ \text{or} \\ 5.231 \end{array} \right\} \leq t \leq \left\{ \begin{array}{l} 18.769 \\ \text{or} \\ 18.770 \end{array} \right.$$

(d)
$$C = 0.05 \int_{\substack{5.231 \\ \text{or} \\ 5.230}}^{\substack{18.770 \\ \text{or} \\ 18.769}} \left(\left[80 - 10 \cos\left(\frac{\pi t}{12}\right) \right] - 78 \right) dt$$

$$= 0.05(101.92741) = 5.096 \approx \$5.10$$

1: bell-shaped graph
 minimum 70 at $t = 0, t = 24$ only
 maximum 90 at $t = 12$ only

3 { **2:** integral
 1: limits and $1/(14 - 6)$
 1: integrand
1: answer
 0/1 if integral not of the form
 $\frac{1}{b - a} \int_a^b F(t) dt$

2 { **1:** inequality or equation
 1: solutions with interval

3 { **2:** integral
 1: limits and 0.05
 1: integrand
1: answer
 0/1 if integral not of the form
 $k \int_a^b (F(t) - 78) dt$